

US EPA ARCHIVE DOCUMENT

ENVIRONMENTAL MONITORING AND ASSESSMENT PROGRAM- SURFACE WATERS:

FIELD OPERATIONS AND METHODS FOR MEASURING THE ECOLOGICAL CONDITION OF WADEABLE STREAMS

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NOTICE

This research described in this report has been funded wholly or in part by the U.S. Environmental Protection Agency. This document has been prepared at the EPA National Exposure Research Laboratory (Ecological Exposure Research Division, Cincinnati, Ohio) and the National Health and Environmental Effects Research Laboratory (Western Ecology Division, Corvallis, Oregon), under the following contracts and cooperative agreements:

Contract 68-C6-0006 to Dynamac International, Inc.
Contract 68-C1-0022 to Technology Applications, Inc.
Contract 68-C6-0019 to SoBran, Inc.
Contract 68-W5-0065 to OAO, Inc.
Cooperative Agreement CR824682 to Oregon State University

This work is in support of the Environmental Monitoring and Assessment Program (EMAP). It has been subjected to the Agency's peer and administrative review, and approved for publication as an EPA document. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

This publication represents the final revision of the EMAP field operations and methods manual for wadeable streams. Previously, annual revisions have been produced under the same title and EPA document number (EPA/620/R-94/004). The document number for the final revision is modified to distinguish it from earlier revisions while maintaining traceability.

The correct citation for this document is:

Lazorchak, J.M., Klemm, D.J. , and D.V. Peck (editors). 1998. *Environmental Monitoring and Assessment Program -Surface Waters: Field Operations and Methods for Measuring the Ecological Condition of Wadeable Streams*. EPA/620/R-94/004F. U.S. Environmental Protection Agency, Washington, D.C.

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FOREWORD

The National Exposure Research Laboratory (NERL) and the National Health and Environmental Effects Research Laboratory (NHEERL) provide scientific understanding, information and assessment tools that will reduce and quantify the uncertainty in the Agency's exposure and risk assessments for all environmental stressors. Stressors include chemicals, biologicals, radiation, climate, and land and water use changes.

Research at NERL focuses on: (1) characterizing the sources of environmental stressors and the compartments of the environment in which they reside or move; (2) studying the pathways through environmental compartments that lead to exposure of receptors to stressors; (3) investigating intra- and inter compartmental stressor transfers and their transformations; and (4) studying and characterizing receptors and their activities as required to predict or measure stressor exposure. Research products from NERL provide effects researchers and risk assessors with information on stressor sources, pollutant transport and transformations and exposure, and state-of-the-science source-to-receptor predictive exposure models applicable at the appropriate temporal scales and site, watershed/regional and global scales. It also provides risk managers with receptor-back-to-source and stressor-back-to-cause analyses and evaluations of alternative mitigation, management or restoration strategies from an exposure perspective.

Ecological research at NHEERL contribute to improving hazard identification, dose-response assessments, and risk characterization at multiple spatial and temporal scales. Research products from NHEERL include improved assessment methods and improved approaches to interpreting the data acquired by these methods. Major uncertainties in assessing the effects on ecosystems resulting from exposure to environmental stressors are addressed through the development of the tools necessary for effective monitoring of ecosystems and their components, by mechanistic studies, and through modeling.

To accomplish its mission, NERL conducts fundamental and applied research designed to:

1. Characterize air, soil, surface water, sediment, and subsurface systems to evaluate spatial and temporal patterns, exposure to environmental stressors/pollutants;
2. Identify, quantify, and predict the physical, chemical, biological and biochemical behavior of stressors, including characterization of their sources, transformations pathways and other factors that determine stressor exposure to humans and ecosystems across multiple media
3. Characterize the ecological and human receptors potentially impacted by stressors and pollutants;
4. Measure, predict, and apply data on environmental stressors to characterize exposure to humans and ecosystems;
5. Incorporate scientific understanding of environmental processes and ecosystem behavior, along with environmental exposure data, into predictive multimedia models to estimate exposure and to evaluate mitigation, restoration, prevention and management options;
6. Develop and implement receptor level exposure and dose models to provide risk assessors with better and more refined estimates of exposure and dose.
7. Develop chemical, physical, and biological measurement methods to identify and quantify environmental stressors and to characterize the environment;
8. Develop quality assurance methodologies for chemical, physical, radiological, and biological analyses;
9. Develop and apply geographical informational systems, remote sensing, photographic interpretation, information management technologies, software engineering technologies, computational chemistry, expert systems, and high performance computing to support the application of exposure and risk assessment tools;
10. Demonstrate, field test/evaluate, and transfer scientific information, measurement and quality assurance protocols, data bases, predictive exposure and risk assessment tools, and other innovative exposure assessment technologies, and provide environmental education materials to support Program Offices, Regions, State/Municipal/Tribal governments, and other Federal Agencies;
11. Provide technical support to Program Offices, Regions, State/Municipal/Tribal governments and other Federal Agencies to help in performing state-of-the-science exposure assessments of known certainty.

Research activities at NHEERL related to improving ecosystem risk assessment are designed to:

1. Develop and evaluate appropriate and meaningful indicators of ecological condition and develop associated criteria to characterize condition.

2. Develop and test approaches for monitoring frameworks that are integrated over multiple spatial and temporal scales to provide representative information about spatial extent of ecosystem resources, their current status (i.e., baseline condition) and how condition is changing through time.
3. Develop approaches to demonstrate relationships between effects on ecological condition and the relative magnitude of current stressors at multiple scales.

This field operations and methods manual represents a collaborative effort among principal investigators at NERL and NHEERL. The manual describes guidelines and standardized procedures for evaluating the biological integrity of surface waters of streams. It was developed to provide the Environmental Monitoring and Assessment Program (EMAP) with bioassessment methods for determining the status and monitoring trends of the environmental condition of freshwater streams. These bioassessment studies are carried out to assess biological criteria for the recognized beneficial uses of water, to monitor surface water quality, and to evaluate the health of the aquatic environment.

PREFACE

The Ecosystems Research Branch (ERB), Ecological Exposure Research Division, National Exposure Research Laboratory, U.S. Environmental Protection Agency - Cincinnati is responsible for field and laboratory exposure methods and ecological indicators that are used in assessing aquatic ecosystems. Research areas include the development, evaluation, validation, and standardization of Agency methods for the collection of biological field and laboratory data. These methods can be used by USEPA regional, enforcement, and research programs engaged in inland, estuarine, and marine water quality and permit compliance monitoring, and status and/or trends monitoring for the effects of impacts on aquatic organisms, including phytoplankton, zooplankton, periphyton, macrophyton, macroinvertebrates, and fish. The program addresses methods and techniques for sample collection; sample preparation; processing of structural and functional measures by using organism identification and enumeration; the measurement of biomass and benthic metabolism; the bioaccumulation and pathology of toxic substances; acute, chronic, and sediment toxicity; the computerization, analysis, and interpretation of biological data; and ecological assessments. ERB also includes field and laboratory support of the ecological biomarker research program and transfer of monitoring technology to the regions and state programs.

This document contains the EMAP-Surface Water field operations and bioassessment methods for evaluating the health and biological integrity of wadeable freshwater streams.

ABSTRACT

The methods and instructions for field operations presented in this manual for surveys of wadeable streams were developed and tested during 5 years of pilot and demonstration projects (1993 through 1997). These projects were conducted under the sponsorship of the U.S. Environmental Protection Agency and its collaborators through the Environmental Monitoring and Assessment Program (EMAP). This program focuses on evaluating ecological conditions on regional and national scales. This document describes procedures for collecting data, samples, and information about biotic assemblages, environmental measures, or attributes of indicators of stream ecosystem condition. The procedures presented in this manual were developed based on standard or accepted methods, modified as necessary to adapt them to EMAP sampling requirements. They are intended for use in field studies sponsored by EMAP, and related projects such as the USEPA Regional Environmental Monitoring and Assessment Program (R-EMAP), and the Temporally Integrated Monitoring of Ecosystems study (TIME). In addition to methodology, additional information on data management, safety and health, and other logistical aspects is integrated into the procedures and overall operational scenario. Procedures are described for collecting field measurement data and/or acceptable index samples for several response and stressor indicators, including water chemistry, physical habitat, benthic macroinvertebrate assemblages, aquatic vertebrate assemblages, fish tissue contaminants, periphyton assemblages, sediment community metabolism, and sediment toxicity. The manual describes field implementation of these methods and the logistical foundation constructed during field projects. Flowcharts and other graphic aids provide overall summaries of specific field activities required to visit a stream site and collect data for these indicators. Tables give step-by-step protocol instructions. These figures and tables can be extracted and bound separately to make a convenient quick field reference for field teams. The manual also includes example field data forms for recording measurements and observations made in the field and sample tracking information. Checklists of all supplies and equipment needed for each field task are included to help ensure that these materials are available when required.

TABLE OF CONTENTS

Section	Page
NOTICE	ii
FOREWORD	iv
PREFACE	vii
ABSTRACT	viii
FIGURES	xiv
TABLES	xvii
ACKNOWLEDGMENTS	xx
ACRONYMS, ABBREVIATIONS, AND MEASUREMENT UNITS	xxi
1 INTRODUCTION	1
1.1 OVERVIEW OF EMAP-SURFACE WATERS	2
1.2 STREAM SAMPLING COMPONENTS OF EMAP-SURFACE WATERS	3
1.2.1 Mid-Atlantic Highlands Assessment Project	3
1.2.2 Mid-Atlantic Integrated Assessment Program	4
1.2.3 Temporal Integrated Monitoring of Ecosystems Project	4
1.2.4 Other Projects	5
1.3 SUMMARY OF ECOLOGICAL INDICATORS	5
1.3.1 Water Chemistry	5
1.3.2 Physical Habitat	6
1.3.3 Periphyton Assemblage	6
1.3.4 Sediment Community Metabolism	7
1.3.5 Benthic Macroinvertebrate Assemblage	7

TABLE OF CONTENTS (CONTINUED)

Section	Page
1.3.6 Aquatic Vertebrate Assemblages	8
1.3.7 Fish Tissue Contaminants	9
1.3.8 Sediment Toxicity	10
1.4 OBJECTIVES AND SCOPE OF THE FIELD OPERATIONS AND METHODS MANUAL	10
1.5 QUALITY ASSURANCE	11
1.6 LITERATURE CITED	12
 2 OVERVIEW OF FIELD OPERATIONS	 17
2.1 DAILY OPERATIONAL SCENARIO	17
2.2 GUIDELINES FOR RECORDING DATA AND INFORMATION	18
2.3 SAFETY AND HEALTH	20
2.3.1 General Considerations	20
2.3.2 Safety Equipment and Facilities	24
2.3.3 Safety Guidelines for Field Operations	24
2.4 LITERATURE CITED	26
 3 BASE LOCATION ACTIVITIES	 27
3.1 ACTIVITIES BEFORE EACH STREAM VISIT	27
3.1.1 Confirming Site Access	27
3.1.2 Daily Sampling Itinerary	29
3.1.3 Instrument Inspections and Performance Tests	29
3.1.3.1 Global Positioning System Receiver	29
3.1.3.2 Dissolved Oxygen Meter	30
3.1.3.3 Conductivity Pens or Conductivity Meters	30
3.1.3.4 Current Velocity Meters	32
3.1.4 Preparation of Equipment and Supplies	32
3.2 ACTIVITIES AFTER EACH STREAM VISIT	36
3.2.1 Equipment Care	36
3.2.2 Sample Tracking, Packing, and Shipment	37
3.3 EQUIPMENT AND SUPPLIES	42
3.4 LITERATURE CITED	44

TABLE OF CONTENTS (CONTINUED)

Section	Page
4 INITIAL SITE PROCEDURES	45
4.1 SITE VERIFICATION ACTIVITIES	45
4.1.1 Locating the Index Site	45
4.1.2 Determining the Sampling Status of a Stream	48
4.1.3 Sampling During or After Rain Events	48
4.1.4 Site Photographs	48
4.2 LAYING OUT THE SAMPLING REACH	49
4.3 MODIFIED PROCEDURES FOR DRY AND INTERMITTENT STREAMS	53
4.4 EQUIPMENT AND SUPPLIES	53
5 WATER CHEMISTRY	57
5.1 SAMPLE COLLECTION	58
5.2 FIELD MEASUREMENTS	58
5.3 EQUIPMENT AND SUPPLIES	59
5.4 LITERATURE CITED	59
6 STREAM DISCHARGE	67
6.1 VELOCITY-AREA PROCEDURE	67
6.2 TIMED FILLING PROCEDURE	70
6.3 NEUTRALLY-BUOYANT OBJECT PROCEDURE	72
6.4 EQUIPMENT AND SUPPLIES	74
6.5 LITERATURE CITED	74
7 PHYSICAL HABITAT CHARACTERIZATION	77
7.1 COMPONENTS OF THE HABITAT CHARACTERIZATION	79
7.2 HABITAT SAMPLING LOCATIONS WITHIN THE SAMPLING REACH	81
7.3 LOGISTICS AND WORK FLOW	81
7.4 THALWEG PROFILE AND LARGE WOODY DEBRIS MEASUREMENTS	84
7.4.1 Thalweg Profile	84
7.4.2 Large Woody Debris Tally	92

TABLE OF CONTENTS (CONTINUED)

Section	Page
7.5 CHANNEL AND RIPARIAN CROSS-SECTION MEASUREMENTS	94
7.5.1 Slope and Bearing	94
7.5.2 Substrate and Channel Dimensions	99
7.5.3 Bank Characteristics	101
7.5.4 Canopy Cover Measurements	105
7.5.5 Riparian Vegetation Structure	109
7.5.6 Instream Fish Cover, Algae, Aquatic Macrophytes	112
7.5.7 Human Influence	114
7.6 EQUIPMENT AND SUPPLIES	114
7.7 LITERATURE CITED	117
8 PERIPHYTON	119
8.1 SAMPLE COLLECTION	119
8.2 PREPARATION OF LABORATORY SAMPLES	122
8.2.1 ID/Enumeration Sample	122
8.2.2 Chlorophyll Sample	124
8.2.3 Biomass Sample	128
8.2.4 Acid/Alkaline Phosphatase Activity Sample	128
8.3 EQUIPMENT AND SUPPLIES	131
8.4 LITERATURE CITED	131
9 SEDIMENT COMMUNITY METABOLISM	133
9.1 SAMPLE COLLECTION	133
9.2 DETERMINING SEDIMENT RESPIRATION	135
9.3 EQUIPMENT AND SUPPLIES	135
10 SEDIMENT TOXICITY	141
10.1 SAMPLE COLLECTION AND PREPARATION	141
10.2 EQUIPMENT AND SUPPLIES	141
11 BENTHIC MACROINVERTEBRATES	147
11.1 SAMPLE COLLECTION	149
11.2 SAMPLE PROCESSING	155
11.3 EQUIPMENT AND SUPPLY CHECKLIST	155

TABLE OF CONTENTS (CONTINUED)

Section	Page
11.4 LITERATURE CITED	158
12 AQUATIC VERTEBRATES	161
12.1 SAMPLE COLLECTION	161
12.1.1 Electrofishing	163
12.1.2 Seining	167
12.2 SAMPLE PROCESSING	169
12.2.1 Taxonomic Identification and Tally	169
12.2.2 External Examination and Length Measurements	172
12.2.3 Preparing Voucher Specimens	175
12.3 EQUIPMENT AND SUPPLIES	180
12.4 LITERATURE CITED	180
13 FISH TISSUE CONTAMINANTS	183
13.1 PREPARING COMPOSITE SAMPLES FOR PRIMARY AND SECONDARY TARGET SPECIES	183
13.2 EQUIPMENT AND SUPPLIES	189
14 RAPID HABITAT AND VISUAL STREAM ASSESSMENTS	193
14.1 RAPID HABITAT ASSESSMENT	193
14.2 VISUAL STREAM ASSESSMENT	194
14.3 EQUIPMENT AND SUPPLIES	208
14.4 LITERATURE CITED	208
15 FINAL SITE ACTIVITIES	211
Appendix	Page
A EQUIPMENT AND SUPPLY CHECKLISTS	A-1
B QUICK REFERENCE GUIDES	B-1
C FIELD DATA FORMS	C-1
D SPECIES CODES FOR AQUATIC VERTEBRATES: MID-ATLANTIC REGION ..	D-1
E MODIFIED PROTOCOL FOR COLLECTING BENTHIC MACROINVERTEBRATES	E-1

FIGURES

Figure	Page
2-1. General sequence of stream sampling activities	19
3-1. Activities conducted at base locations.	28
3-2. Performance test procedure for a dissolved oxygen meter.	31
3-3. Sample container labels.	37
3-4. Equipment and supply checklist for base location activities.	43
4-1. Verification Form (page 1).	47
4-2. Verification Form (page 2).	51
4-3. Sampling reach features.	52
4-4. Equipment and supplies checklist for initial site activities.	55
5-1. Completed sample labels for water chemistry.	59
5-2. Sample Collection Form (page 2), showing data recorded for water chemistry samples.	61
5-3. Field Measurement Form (page 1), showing data recorded for water chemistry. . . .	63
5-4. Checklist of equipment and supplies for water chemistry.	64
6-1. Layout of channel cross-section for obtaining discharge data by the velocity-area procedure.	68
6-2. Field Measurement Form (page 2), showing data recorded for all three discharge measurement procedures.	71
6-3. Use of a portable weir in conjunction with a calibrated bucket to obtain an estimate of stream discharge.	72
6-4. Equipment and supply checklist for stream discharge.	76
7-1. Sampling reach layout for physical habitat measurements (plan view).	82
7-2. Thalweg Profile and Woody Debris Form.	87
7-3. Large woody debris influence zones.	94

FIGURES (CONTINUED)

Figure	Page
7-4. Channel slope and bearing measurements.	96
7-5. Slope and Bearing Form.	98
7-6. Substrate sampling cross-section.	101
7-7. Channel/Riparian Cross-section and Thalweg Profile Form.	103
7-8. Schematic showing bankfull channel and incision for channels.	106
7-9. Schematic of modified convex spherical canopy densiometer.	107
7-10. Boundaries for visual estimation of riparian vegetation, fish cover, and human influences.	110
7-11. Checklist of equipment and supplies for physical habitat.	116
8-1. Index sampling design for periphyton.	120
8-2. Sample Collection Form (page1) showing data recorded for periphyton samples. .	123
8-3. Completed set of periphyton sample labels.	124
8-4. Filtration apparatus for preparing chlorophyll and biomass subsamples for periphyton.	127
8-5. Checklist of equipment and supplies for periphyton.	132
9-1. Field Measurement Form (page 1), showing data for sediment metabolism samples.	138
9-2. Completed sample labels for sediment metabolism.	139
9-3. Checklist of equipment and supplies for sediment metabolism.	140
10-1. Completed sample label for sediment toxicity.	143
10-2. Sample Collection Form (page 2), showing information recorded for a sediment toxicity sample.	144
10-3. Checklist of equipment and supplies for sediment toxicity	145
11-1. Modified kick net.	148
11-2. Index sampling design for benthic macroinvertebrates.	150
11-3. Sample Collection Form (page 1), showing information for benthic macroinvertebrate samples.	154
11-4. Checklist for benthic macroinvertebrate sampling activities.	155
11-5. Completed labels for benthic macroinvertebrate samples.	158
11-6. Blank labels for benthic invertebrate samples.	159

FIGURES (CONTINUED)

Figure	Page
11-7. Equipment and supply checklist for benthic macroinvertebrates.	160
12-1. Index sample design for aquatic vertebrate sampling.	162
12-2. Vertebrate Collection Form (page1).	166
12-3. Vertebrate Collection Form (page 2).	171
12-4. Fish length measurements.	174
12-5. Vertebrate Length Recording Form (page 1).	176
12-6. Completed voucher sample label and specimen bag tag for aquatic vertebrates.	178
12-7. Equipment and supplies checklist for aquatic vertebrates.	181
13-1. Completed sample labels for fish tissue contaminants.	189
13-2. Sample Collection Form showing information recorded for fish tissue samples. . .	190
13-3. Equipment and supplies checklist for fish tissue contaminants.	191
14-1. Rapid Habitat Assessment Form for riffle/run prevalent streams (page 1).	199
14-2. Rapid Habitat Assessment Form for riffle/run prevalent streams (page 2).	200
14-3. Rapid Habitat Assessment Form for pool/glide prevalent streams (page 1).	201
14-4. Rapid Habitat Assessment Form for glide/pool prevalent streams (page 2).	202
14-5. Assessment Form (page 1).	206
14-6. Assessment Form (page 2).	207
14-7. Checklist of equipment and supplies required for rapid habitat and visual stream assessments.	209

TABLES

Table	Page
2-1. ESTIMATED TIMES AND DIVISION OF LABOR FOR FIELD ACTIVITIES	18
2-2. GUIDELINES FOR RECORDING FIELD DATA AND OTHER INFORMATION	21
2-3. GENERAL HEALTH AND SAFETY CONSIDERATIONS	23
2-4. GENERAL SAFETY GUIDELINES FOR FIELD OPERATIONS	25
3-1. STOCK SOLUTIONS, USES, AND INSTRUCTIONS FOR PREPARATION	33
3-2. PERFORMANCE CHECK OF CONDUCTIVITY PENS OR CONDUCTIVITY METERS	34
3-3. GENERAL PERFORMANCE CHECKS FOR CURRENT VELOCITY METERS	35
3-4. EQUIPMENT CARE AFTER EACH STREAM VISIT	38
3-5. GENERAL GUIDELINES FOR PACKING AND SHIPPING SAMPLES	40
4-1. SITE VERIFICATION PROCEDURES	46
4-2. GUIDELINES TO DETERMINE THE INFLUENCE OF RAIN EVENTS	49
4-3. LAYING OUT THE SAMPLING REACH	50
4-4. MODIFICATIONS FOR DRY CHANNELS AND INTERMITTENT STREAMS	54
5-1. SAMPLE COLLECTION PROCEDURES FOR WATER CHEMISTRY	60
5-2. PROCEDURES FOR STREAMSIDE AND IN SITU CHEMISTRY MEASUREMENTS	62
6-1. VELOCITY-AREA PROCEDURE FOR DETERMINING STREAM DISCHARGE . . .	69
6-2. TIMED FILLING PROCEDURE FOR DETERMINING STREAM DISCHARGE	73
6-3. NEUTRALLY BUOYANT OBJECT PROCEDURE FOR DETERMINING STREAM DISCHARGE	75
7-1. COMPONENTS OF PHYSICAL HABITAT CHARACTERIZATION	80
7-2. THALWEG PROFILE PROCEDURE	85
7-3. CHANNEL UNIT AND POOL FORMING CATEGORIES	89
7-4. PROCEDURE FOR TALLYING LARGE WOODY DEBRIS	93

TABLES (CONTINUED)

Table	Page
7-5. PROCEDURE FOR OBTAINING SLOPE AND BEARING DATA	97
7-6. SUBSTRATE MEASUREMENT PROCEDURE	102
7-7. PROCEDURE FOR MEASURING BANK CHARACTERISTICS	104
7-8. PROCEDURE FOR CANOPY COVER MEASUREMENTS	108
7-9. PROCEDURE FOR CHARACTERIZING RIPARIAN VEGETATION STRUCTURE	111
7-10. PROCEDURE FOR ESTIMATING INSTREAM FISH COVER	113
7-11. PROCEDURE FOR ESTIMATING HUMAN INFLUENCE	115
8-1. PROCEDURE FOR COLLECTING COMPOSITE INDEX SAMPLES OF PERIPHYTON	121
8-2. PREPARATION OF ID/ENUMERATION SAMPLES FOR PERIPHYTON	125
8-3. PROCEDURE FOR PREPARING CHLOROPHYLL SAMPLES FOR PERIPHYTON	126
8-4. PROCEDURE FOR PREPARING BIOMASS SAMPLES FOR PERIPHYTON	129
8-5. PROCEDURE FOR PREPARING ACID/ALKALINE PHOSPHATASE ACTIVITY SAMPLES FOR PERIPHYTON	130
9-1. SEDIMENT COLLECTION PROCEDURE	134
9-2. PROCEDURE TO MEASURE SEDIMENT RESPIRATION	136
10-1. PROCEDURE FOR PREPARING SEDIMENT TOXICITY SAMPLES	142
11-1. PROCEDURE TO COLLECT KICK NET SAMPLES FROM RIFFLE AND RUN HABITATS	151
11-2. PROCEDURE TO COLLECT KICK NET SAMPLES FROM POOL AND GLIDE HABITATS	153
11-3. PROCEDURE FOR PREPARING COMPOSITE SAMPLES FOR BENTHIC MACROINVERTEBRATES	157
12-1. PROCEDURE TO COLLECT AQUATIC VERTEBRATES BY ELECTROFISHING	165
12-2. PROCEDURES TO COLLECT AQUATIC VERTEBRATES BY SEINING	168

TABLES (CONTINUED)

Table	Page
12-3. PROCEDURE TO IDENTIFY, TALLY, AND EXAMINE AQUATIC VERTEBRATES	170
12-4. EXTERNAL ANOMALY CATEGORIES AND CODES	173
12-5. GUIDELINES AND PROCEDURES FOR PREPARING AQUATIC VERTEBRATE VOUCHER SPECIMENS	177
13-1. PROCEDURE TO PREPARE THE PRIMARY COMPOSITE SAMPLE FOR FISH TISSUE CONTAMINANTS	185
13-2. PROCEDURE TO PREPARE THE SECONDARY COMPOSITE SAMPLE FOR FISH TISSUE CONTAMINANTS	187
14-1. DESCRIPTIONS OF HABITAT PARAMETERS USED IN THE RAPID ASSESSMENT OF STREAMS	195
14-2. PROCEDURE FOR CONDUCTING THE RAPID HABITAT ASSESSMENT	198
14-3. PROCEDURE FOR CONDUCTING THE FINAL VISUAL ASSESSMENT OF A STREAM	204

ACKNOWLEDGMENTS

Review comments from the following persons are gratefully acknowledged: D.J. Chaloud, (National Exposure Research Laboratory, Las Vegas, NV), P.A. Lewis (U.S. EPA, retired), W. Thoeny (SoBran, Inc., Cincinnati, OH), P.M. Nolan (U.S. EPA Region 1, Lexington, MA), H. R. Preston, (U.S. EPA Region 3, Wheeling, WV), R.D. Spear, (U.S. EPA Region 2, Edison, NJ), A. Euresi (EPA Region 6, Houston, TX), M.D. Bilger (U.S. Geological Survey, Lemoyne, PA), C. Yoder and M. Smith (Ohio EPA, Columbus, OH), and C. McFarlane (U.S. EPA, Corvallis, OR). The efforts and dedication of numerous field personnel in implementing these protocols and providing feedback for clarification and improvement are also recognized. M. Hails-Avery and H. Gronemyer (National Asian Pacific Center on Aging, Senior Environmental Employment Program, Corvallis, OR) assisted with preparing many of the figures. G. Mosher (OAO Inc., Corvallis, OR) prepared the field data forms.

ACRONYMS, ABBREVIATIONS, AND MEASUREMENT UNITS

Acronyms and Abbreviations

AFDM	Ash-free dry mass
APA	Acid/Alkaline Phosphatase Activity
BPJ	Best Professional Judgment
BOD	Biological Oxygen Demand
CENR	(White House) Committee on the Environment and Natural Resources
CFR	Code of Federal Regulations
DC	Direct Current
DIC	Dissolved Inorganic Carbon
DLGs	Digital Line Graphs
DO	Dissolved oxygen
EERD	Ecological Exposure Research Division
EMAP	Environmental Monitoring and Assessment Program
EMAP-SW	Environmental Monitoring and Assessment Program-Surface Waters Resource Group
EPA	U.S. Environmental Protection Agency
ERB	Ecosystems Research Branch
GPS	Global Positioning System
ID	identification
LWD	Large Woody Debris
MAHA	Mid-Atlantic Highlands Assessment
MAIA	Mid-Atlantic Integrated Assessment
NAWQA	National Water-Quality Assessment Program
NERL	National Exposure Research Laboratory
NHEERL	National Health and Environmental Effects Research Laboratory
ORD	Office of Research and Development
OSHA	Occupational Safety and Health Administration
P-Hab	physical habitat
PVC	polyvinyl chloride
QA	quality assurance
QC	quality control

ACRONYMS, ABBREVIATIONS, AND MEASUREMENT UNITS (CONTINUED)

Acronyms and Abbreviations (continued)

RBP	(EPA) Rapid Bioassessment Protocol
R-EMAP	Regional Environmental Monitoring and Assessment Program
SL	Standard length
SOP	Standard Operating Procedure
TIME	Temporally Integrated Monitoring of Ecosystems
TL	Total length
USGS	United States Geological Survey
WED	Western Ecology Division
YOY	young of year
YSI	Yellow Springs Instrument system

Measurement Units

amps	amperes
cm	centimeter
gal	gallon
ha	hectare
Hz	Hertz
in	inches
L	liter
m	meter
m ²	square meters
mg/L	milligram per liter
mm	millimeter
: m	micrometer
: S/cm	microsiemens per centimeter
msec	millisecond
ppm	parts per million
psi	pounds per square inch
V	volts
VA	volt-ampere